In the Specification:

Please amend the specification as follows:

Please rewrite the paragraph bridging pages 2 and 3 so as to read as follows:

In other words, ~~unevenly distributed is~~ light intensity in the spot of the reproducing laser beam irradiated to the reproducing layer is unevenly distributed. Because of this, temperature is also distributed unevenly therein spontaneously. Therefore, ~~with~~ in such an arrangement wherein the reproducing layer is made of a material whose optical characteristics (mainly transmittance) ~~is~~ are changed by temperature or light intensity distribution, it is possible to increase only the transmittance of that part of the reproducing layer~~,~~ which is at the center of the laser beam spot~~,~~ because temperature is high and light intensity is high in the part at the center of the laser beam spot. When transmittance is increased only in that part of the reproducing layer which is at the center of the laser beam spot, the reflection layer receives only the light of the center of the laser spot. That is, the laser beam spot irradiated on the surface of the reflective layer is virtually reduced. Therefore, in the super-resolution optical data recording medium, it is possible to reproduce a mark having a mark length shorter than a mark of resolution limit of the optical system.

Please rewrite the paragraph located at page 7, lines 3-10 so as to read as follows:

The arrangement in which the thickness of the reproducing layer is thin in view of the above limitation faces the following problem: ~~For~~ for example, in the case that the reproducing layer has a greater transmittance with a thicker thickness, the thin thickness ~~gives limitation in~~ limits how much the laser spot can be reduced, thereby prohibiting the optical data recording medium from having a better resolution limit.

Please rewrite the paragraph bridging pages 7 and 8 so as to read as follows:

To achieve the object, an optical data recording medium, in which irradiation of a light beam is used for ~~receding~~ recording or reproducing data, includes a reproducing layer, provided to face a light-incident surface of the substrate, the reproducing layer for reproduction of a signal from a mark having a mark having a mark length shorter than a mark length of a resolution limit of an optical system of a reproducing apparatus for reproducing the optical data recording medium.

Please rewrite Page 9, line 15, to page 10, line 20, so as to read as follows:

In other words, the reproducing layer can be formed so as to face the light-incident surface of the substrate, after the other layers are provided. Therefore, the reproducing layer can have an arbitrary thickness without limitation from the shape of the other layers. For example, in the case ~~where~~ wherein a reproducing layer is used whose greater thickness gives more greatly changeable transmittance thereof, this

arrangement attains a better resolution and a smaller spot size of the light beam, thereby enabling the reproduction of the signal from a mark having a further shorter mark length. This makes it possible to provide the optical data recording medium that is more excellent in super-resolution property and enables storage/reproduction of data in higher density.

Note that this arrangement attains not only freedom in designing the thickness of the reproducing layer. As described in Examples, improvement in resolution limit was observed in the optical data recording medium having this arrangement and being identical with a conventional optical data recording medium in terms of the thickness of the reproducing layer, and the like condition.

To achieve the object of the present invention, the optical data recording medium, in which irradiation of a light beam is used for reproducing data, includes steps of (i) irradiating the light beam from above the reproducing layer, and (ii) reproducing the mark having a mark length shorter than resolution limit of the optical system of the reproducing apparatus. On ~~the~~ account of this, it becomes possible to reproduce data from the optical data recording medium in which data is recorded in high-density.

Please rewrite page 12, lines 6-7, so as to read as follows:

~~Thereinafter~~Hereinafter, an embodiment of the present invention is explained with reference to figures.

Please rewrite the full paragraph appearing on page 13 so as to read as follows:

The substrate 5 gives appropriate strength to the optical data recording medium 1. On an light-incident surface of the substrate 5 (that surface of the substrate 5 from above which the laser light beam is irradiated; that is, that surface of the substrate 5 above which the reproducing layer 2 is provided), pits and grooves are provided. The pits, which ~~forms~~ form the rise and/or the recess, correspond to recorded data, and the ~~groove~~ grooves are used for guiding, that is, for recording a start address and end address of recording. The optical data recording medium 31 may be provided with both the pits and the grooves, or with either the pits or the grooves. However, in the arrangement in which the optical data recording medium 1 includes the guiding grooves, data can be recorded or reproduced without imposing a burden on a reproducing/recording device.

Please rewrite the first full paragraph appearing on page 15 so as to read as follows:

It is preferable that the reflective layer 4 is a metal film having high reflectance such as an Al film, an Au film, an Ag film, ~~and~~ or a film of an alloy of those compounds. Because the reflective layer 4 is not particularly limited in thickness, ~~and~~ it may have any thickness to realize a desired reflectance. For example, the thickness of the reflective layer 4 may be around 20nm through 100nm.

Please rewrite the paragraph bridging pages 16 and 17 and the full paragraph appearing on page 17 so as to read as follows:

In addition, the optical data recording medium 31 may be so arranged as not to include the light absorption layer 3. In this case, however, the reproducing layer 2 must be made of a material whose optical characteristic is changed only by light intensity, or the reproducing layer 2 must have light-heat converting function by containing a substance which absorbs the reproduction light and ~~generate~~ generates heat.

The reproducing layer 2, which is a translucent material whose transmittance is changed reversibly as a temperature changes, contains a material whose transmittance with respect to a wavelength of the reproduction laser beam 30 increases as a temperature rises. With this arrangement, transmittance is increased only in a temperature-rising part of the laser beam spot of the reproduction laser beam 30 (a smaller spot near at a center of the reproduction beam 30). Accordingly, the diameter of the laser beam spot of the laser beam having passed through the reproducing layer 2 becomes smaller than the diameter of the spot of the reproducing laser beam 30. On ~~the~~ account of this, it is possible to perform reproduction of a shorter mark length.

Please rewrite the paragraph bridging pages 20 and 21 so as to read as follows:

Therefore, the reproducing layer 2 can have an arbitrary thickness without limitation from the shape of the reflective layer 4 because the reproducing layer 2 is formed after the formation of the reflective layer 4 having a rise and/or a recess faithful with the rise and/or the recess of the substrate 5. This arrangement attains a good transmittance distribution along a thickness direction, whereby it becomes possible to perform the reduction of signals from the shorter mark length. Therefore, with this arrangement, it is possible to attain a higher super resolution property and to realize an optical data ~~receding~~ recording medium in which a signal can be recorded in high density, and the signal ~~receding~~ recording in high density can be reproduced.

Please rewrite the second full paragraph appearing on page 21 so as to read as follows:

~~Thereinafter~~Hereinafter, a method of reproducing the optical data recording medium 31 is explained with reference to Fig. 2 (a) and Fig. 2 (b)

Please rewrite the paragraph bridging pages 23 and 24 and the full paragraph appearing on page 24 so as to read as follows:

Accordingly, most of the laser beam irradiated to the optical data recording medium 31 (the laser beam irradiated to the lower temperature area 12) are shielded off by the reproducing layer 2, and only the laser beam irradiated to the higher temperature area 13 passes through the reproducing layer 2 as shown in Fig.3. On ~~the~~ account of this, only the laser beam having passed through the reproducing layer 2 reaches the light absorption layer 3 and the reflective layer 4. Therefore, the spot size of the laser beam produced on a surface of the reflective layer 4 is virtually reduced. Consequently, it is possible to perform reproduction of a mark having a mark length shorter than a mark length of the resolution limit of the optical system.

Note that when the reproducing laser beam 30 having the higher temperature area and the lower temperature area is irradiated, the light absorption layer 3 absorbs the reproducing laser beam 30 and converts the beam into heat. Therefore, the light absorption layer 3 produces a large amount of heat after absorbing the reproducing laser beam 30 having passed through the higher temperature area 13. Because the heat generated in the light absorption layer 3 travels to the reproducing layer 2 located nearby (preferably contiguous to) the light absorption layer 3, temperature in the higher temperature area 13 of the reproducing layer 2 rises more. Accordingly, the transmittance of the laser beam irradiated to the higher temperature area 13 in a reproducing layer 2 ~~decreases~~ increases more. This makes it easier to attain a further smaller spot size of the laser beam on the reflective layer 4, thereby attaining reproduction of higher quality.

Please rewrite the paragraph bridging pages 26 and 27 so as to read as follows:

As described above, that optical data recording medium of the present invention, in which irradiation of a light beam is used for ~~recoding~~ recording or reproducing data, includes a reproducing layer, provided to face a light-incident surface of the substrate. The reproducing layer is for reproduction of a signal from a mark having a mark having a mark length shorter than a resolution limit of an optical system of a reproducing apparatus for reproducing the optical data recording medium.

Please rewrite the paragraph bridging pages 28 and 29 as well as the remainder of page 29 so as to read as follows:

Because the reproducing layer can be provided on that surface of the substrate from above which the laser beam is irradiated after the other layers are provided, it is possible to give the reproducing layer an arbitrary thickness, while letting the reflecting layer have a good rise and/or a good recess. On ~~the~~ account of this, resolution is improved in case where the reproducing layer is made of a material whose transmittance is greatly changed by the thicker film thickness. Also, because the size of the laser beam becomes smaller, it becomes possible to reproduce a shorter mark length. Accordingly, because super-resolution quality is improved, an optical data recording medium in which data is recorded in high-density is obtained.

Note that in the arrangement, not only the film thickness of the reproducing layer is not limited but also resolution limit is improved when a conventional optical data recording medium and film thickness of the reproducing layer are arranged as above. This is described later in Examples.

To achieve the object of the present invention, the optical data recording medium includes (i) the substrate having the rise and/or the recess that contributes recording and/or reproduction on the light incident surface, (ii) functional layers, provided on the light incident surface of the substrate, assisting recording and reproducing data, and (iii) the reproducing layer, provided on the surface of the functional layers, having transmittance that changes in accordance with ~~an~~ a light intensity distribution of the laser beam.

"The functional layers assisting recording and reproducing data" ~~is~~ are one or more layers, which ~~has~~ have functions of reflecting the laser beam, converting light to heat, recording data, or the like function. Each layer may have a single function or multiple functions. This is, the functional layer may have the function of converting light to heat and the function of recording data.

Please rewrite the second full paragraph appearing on page 30 through page 36, line 15 so as to read as follows:

Therefore, with this arrangement, it is possible to give the reproducing layer an arbitrary thickness, while letting the reflecting layer have a good rise and/or a good recess. On ~~the~~ account of this, resolution is improved in ~~case where~~ those cases wherein the reproducing layer is made of a material whose transmittance is greatly changed by the thicker film thickness. Also, it becomes possible to reproduce a shorter mark length. Accordingly, this gives the optical data recording medium a higher super-resolution property, and a high-density optical data recording medium is obtained.

Note that it is desirable that "the rise and/or the recess indicative of data or reproduction position" formed on the substrate includes a groove for recording a start address and an end address of the data, in addition to the pit or groove for recording the data. (The groove for recording the start address and end address of data indicates, after recording the data, where the reproduction point of the data is.) With this arrangement, the recording and reproducing of the data can be carried out without imposing a burden on the reproducing/recording apparatus. Thus, it is possible to reproduce the recorded data in higher density.

To achieve the object of the present invention, the optical data recording medium is so arranged that the reproducing layer includes a material whose transmittance changes in accordance with temperature. Because the transmittance of the reproducing layer changes in accordance with temperature, it becomes possible to attain a smaller size of the light beam spot desirably.~~.~~

To achieve the object of the present invention, the optical data recording medium, at least a part of that surface of the reproducing layer to which the light beam is irradiated is exposed to air.

According to the arrangement, because at least a part of the surface of the reproducing layer to which the laser beam is irradiated is exposed to air, it is possible to attain a desirable difference between refractive index of the air and refractive index of the reproducing layer in irradiating the light beam onto the reproducing layer. On the account of this, it becomes easier to irradiate the laser beam to the reproducing layer.

Furthermore, in the arrangement in which the recording layer has a transmittance that is changeable by heat distribution caused by the light beam, conduction of the heat from the reproducing layer to the other layers is minimized. Thus, it is possible to heat the reproducing layer by the light beam efficiently.

Therefore, according to the foregoing arrangement, not only ~~it is~~ is it possible to prevent heat from transmitting from the reproducing layer, but also it is possible to increase a quantity of the reflected light beam. Accordingly, it is possible to obtain the optical data recording medium in which data is recorded in high density can be reproduced with better quality.

To achieve the object of the present invention, the optical data recording medium includes that light absorption layer for converting the light beam to heat, which is contiguous to the reproducing layer.

In ~~case where~~ those cases wherein an optical data recording medium of the present invention does not include the light absorption layer, the reproducing layer must have an light-heat converting function. In order to provide an light-heat converting function with the reproducing layer, the reproducing layer should be made of (i) a material whose optical characteristics ~~is~~ are changeable only in accordance with light intensity distribution, or (ii) a material which converts light to heat.

On the other hand, according to the foregoing arrangement, the light beam having passed through the reproducing layer can be converted into heat thereby changing the temperature of the reproducing layer by the light beam efficiently with such a simple arrangement. Therefore, it is possible to change the temperature of the reproducing layer without providing a variety of functions with the reproducing layer. On the account of this, a super-resolution optical data recording medium, which costs less and is easier to be fabricated, can be obtained.

To achieve an object of the present invention, the optical data recording medium includes ~~that~~ a reflective layer for reflecting the light beam as one of the functional layers, which is provided between the substrate and the reproducing layer.

In the arrangement in which the reflective layer is provided between the substrate and the reproducing layer, the reproduction layer is formed after the reflecting layer is ~~so~~ formed so as to have the rise and/or the recess well corresponding to the rise and/or the recess of the reflecting layer.

Therefore, with this arrangement, it is possible to give the reproducing layer an arbitrary thickness, while letting the reflecting layer have a good rise and/or a good recess. As a result, the transmittance of the reproducing layer is distributed desirably in a thickness direction of the reproducing layer, thereby making it possible to attain the reproduction of the signal from the shorter mark length. This gives the optical data recording medium a higher super-resolution property.

Because the reflective layer is provided in the optical data recording medium, the optical data recording medium can be effectively reproduced even when the reproducing layer does not have enough reflectance. Thus, the super-resolution optical data recording medium which costs less and possesses high reliability is obtained.

To achieve the object of the present invention, the optical data recording medium includes the ~~reproducing~~ reproduction layer that is made of a metal oxide. Because the reproducing layer is made of ~~the~~ a metal oxide, the super-resolution optical data recording medium of the present invention costs less and possesses ~~high~~ higher reliability than heretofore was the case.

To achieve the object of the present invention, the optical data recording medium includes the reproducing layer that is made of a zinc oxide. Because the reproducing layer is made of ~~a~~ zinc oxide, it is possible to read the non-flat surface having shorter mark length and to write data in high density in the optical data recording medium.

To achieve an object of the present invention, the optical data recording medium includes ~~the~~ a light absorption layer made of one of silicon, germanium ~~and~~ or an alloy of silicon and germanium. Because the light absorption layer is made of one of silicon, ~~and~~ germanium ~~and~~ or an alloy of silicon and germanium, it is possible to attain ~~the~~ an optical data recoding medium having ~~the~~ a reproducing layer whose temperature can be changed desirably by using the light beam, while keeping the low cost of the optical data recording medium.

To achieve the object of the present invention, the reproducing method of an optical recording medium includes the steps of (i) irradiating the laser beam from above the reproducing layer, and (ii) reproducing the mark having a mark length shorter than resolution limit of the optical system of the reproducing apparatus. On the account of this, it becomes possible to reproduce data recorded in the high-density optical data recording medium.

The invention being thus described, it will be obvious that the same ~~way~~ may be varied in many ways. All such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Furthermore, the present invention can be structured as follows.

A first optical data recording medium, in which irradiation of a light beam is used for ~~recoding~~ recording or reproducing data, at least includes (i) a substrate and (ii) a reproducing layer, provided to face a light-incident surface of the substrate, for reproduction of a signal from a mark having a mark having a mark length shorter than a resolution limit of an optical system of a reproducing apparatus for reproducing the optical data recording medium, wherein the reproducing layer is provided on a surface of the substrate to which a laser beam is irradiated.

Please rewrite the final full paragraph on page 37 so as to read as follows:

A reproducing method of any one of the first through the eighth optical data recording media includes a step of reproducing a shorter mark length signal than resolution limit of optical system of the ~~a~~ reproducing apparatus.

Please rewrite the first full paragraph on page 38 so as to read as follows:

As an Example 1, an optical data recording medium having the following arrangement was produced (hereinafter, referred as "Example 1 disc"). As shown in the Fig. 1, pits creating a non-flat surface are provided on polyolefin-based resin substrate 5 ~~and~~ having a 0.5mm thickness. The pits corresponded to recorded data. On that surface of the polyolefin-based resin substrate 5 on which the pits are formed, an A1 layer 4 (30nm in thickness) used as a reflective layer, as Si layer 4 (50nm in thickness) used as an light absorption layer, and a ZnO film 2 (225nm in thickness) used as a reproducing layer were formed in this order. On a top surface of the reproducing layer 2, glass 1 (0.5mm in thickness) as a cover layer was placed.

Please rewrite the paragraph bridging pages 38 and 39 so as to read as follows:

Also, as a Comparative Example, an optical data recording medium with following arrangement was produced (hereinafter referred as "conventional disc"). As shown in Fig. 4, pits creating a non-flat surface ~~are~~ were provided on a polyolefin-based resin substrate 25 having 0.5 mm thickness. On the surface of the polyolefin-based resin substrate having the pits, a ZnO film 22 (225nm in thickness) used as a reproducing layer, a Si layer 23 used as an light absorption layer 23 (50nm in thickness), and an A1 layer 24 (30nm in thickness) ~~are~~ were layered in this order.

Please rewrite the second full paragraph appearing on page 39 so as to read as follows:

Note that in both the discs, the layers having the same functions were identical in material and in thickness, in order to perform the comparison between the discs more accurately. Moreover, because the same measuring apparatus was used to compare the Example 1 disc and the conventional disc (so that optical systems until the light ~~reaches~~ reached the reproducing layers were identical in both the discs), the conventional disc ~~includes~~ included a glass 1 which was as thick as the glass 1 which the Example 1 disc included.

Please rewrite the paragraph bridging pages 39 and 40 so as to read as follows:

As to the Example 1 disc, ~~carried out was~~ measurement of a C/N (appraisal standard of signal quality) of pits having 0.1μm through 0.5μm mark length (pit length), and C/N obtained by irradiation of the reproducing laser beam 30 onto the Example 1 disc from above the glass. The result is graphed in a solid line in Fig. 5. In Fig. 5, the horizontal axis shows the pit length, and the vertical axis is OTF (optical transfer function) showing C/N (appraisal standard of signal quality) and dependency of C/N on recording mark length. In other words, the vertical axis shows super-resolution quality.

Please rewrite the first full paragraph on page 40 so as to read as follows:

As to the conventional disc, ~~carried out was~~ a measurement of a C/N (appraisal standard of signal quality) of a pit having 0.1 through 0.5μm mark length (pit length) was carried out. The result is graphed in a broken line in Fig. 5.

Please rewrite the second full paragraph on page 40 so as to read as follows:

According to Fig. 5, the Example 1 disc had a very high C/N values of 40 to 45dB for the mark lengths (pit length) down to about 0.14μm. (In addition, even for the pit length shorter than 0.14μm, the C/N value of the Example 1 disc ~~was~~ were still high, for example, the C/N value was 35dB when the pit length was around 0.12μm). In general, a C/N value needs to be no less than 40dB in order to reproduce data finely. Therefore, in Example 1 disc used, it was possible to reproduce data finely for the pit lengths down to 0.14μm. On the other hand, in the conventional disc, the C/N value decreased dramatically for the mark length shorter than 0.2μm.

Please rewrite the paragraph bridging pages 40 and 41 so as to read as follows:

For the pit length 0.14μm, the C/N of the Example 1 disc was around 40dB and the C/N of the conventional disc was 17 dB. Also, for the pit length 0.2μm or less, the C/N of the conventional disc decreased dramatically to a value lower than 40 dB. Therefore, for the conventional disc, the limit of the pit length was 0.20μm for fine reproduction. As described above, the comparison showed that the arrangement of the present invention attained ~~such~~ dramatically high super-resolution quality and the reproduction of the signal from the shorter mark length with high signal quality. ~~(The arrangement of the present invention including the reproducing layer provided on that surface (light-incident surface) of the substrate to which a laser beam is irradiated — that is, the reproducing is located furthest from the substrate except the cover layer –, and the reproducing layer is adjacent to a layer of air).~~

Please rewrite the paragraph bridging pages 41 and 42 so as to read as follows:

An optical data recording medium (hereinafter Example 2 disc) used in Example 2 was identical with the Example 1 disc in the Example 1, except that the reproducing layer of the Example 2 disc was made of, instead of ZnO, SnO_2. Correlation between mark lengths for signals, and qualities of the signals was measured for the Example 1 disc and Example 2 disc. The measurement was carried out as in Example 1. That is, ~~carried out was~~ the measurement of a C/N (appraisal standard of signal quality) of pits having 0.1μm through 0.5μm mark length (pit length) was carried out.